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Design of Fit Between Die and Insert

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Abstract: Now-a-days increasing the productivity and the quality of the part manufactured are the main challenges in the steel forging industry. Die creation is one among the big challenge faced by the industry now-a-days. For small parts that have to be forged the technique used is to create an insert which should perfectly fit in the die block. Presently the technique used is by creating an shrinkage fit by heating the die block up to 550°C for a period of 3 hours so that the diameter of the die block increases so that the insert with larger diameter than the die block in cold condition can perfectly fit in the die block. This technique is not economical as the cost for heating the die block is quite high.

Keywords: Die and insert, Forging

ALTERNATIVE SOLUTION:

1. **Assemblages of split die block using dovetail.**
2. **Vertical tapered key design.**

1. INTRODUCTION

1.1 About Steel and Industrial Forging limited (SIFL)

Steel & Industrial Forgings Limited (SIFL) is an AS9100 C certified, Public Sector undertaking fully owned by Government of Kerala. Incorporated in 1983 and Started commercial production in 1986, SIFL rapidly forged ahead to become a name to reckon with. SIFL is masters in Titanium and Special alloy forgings. Untiring efforts of two decades has saddled SIFL firmly in the Forging Industry of India and abroad with best ratings for its products and services.

Main production machinery of SIFL comprise closed die forging hammers of 16 Ton, 10 Ton (16000 ft.lb) and 6Ton (10650 ft.lb) capacity. SIFL's critical forgings are supplied to various sectors like Aerospace sector, Defense sector, Railway sector, Heavy Engineering sector, Earth Moving sector, Agriculture sector, and Automobile sector. Main production machinery of SIFL comprise closed die forging hammers of 16 Ton, 10 Ton (16000 ft.lb) and 6Ton (10650 ft.lb) capacity. SIFL's critical forgings are supplied to various sectors like Aerospace sector, Defense sector, Railway sector, Heavy Engineering sector, Earth Moving sector, Agriculture sector, and Automobile sector.

1.2 About Forging Technology

Forging the process of shaping heated metal by the application of sudden blows or steady pressure and makes use of characteristic of plasticity of the material. A metal such as steel can be shaped in a cold state but the application of heat lowers the yield point and makes permanent deformation easier.

Forging can be divided into two groups.

- Hand forging
- Press forging.

Hand forging or black-smiting is used for small quantity production and for special work whereas machine forging involves the use of dies and is generally used for mass production.

1.3 Forging Dies

Forging dies into which impressions have been cut are keyed into the movable ram of the forging press and the stationary anvil cap. The dies should be perfectly aligned to produce accurate components. Forging dies are classified as follows:

Based on operations.

- Drop hammer dies
- Press dies
- Up setter dies
- Trimming dies

Based on manufacturing process.

- Open die
- Closed die

2. COMPANY PROFILE

SIFL manufacture closed die forgings in the weight range of 5 kg to 750 kg and open die forgings within 1kg to 75kg net weight per piece and ring rolling up to 650mmOD. The company has got the capability to manufacture forgings out of Carbon steels, Alloysteels, Stainless steels, Maraging steels, Aluminum alloys, Titanium alloys, Inconel (Su 718) etc.

2.1 Die Design and Development

SIFL's design & engineering capabilities are ably backed by a well equipped Die Shop, set up along modern lines with Double Spindle Copy Milling Machines, Electrical Die Sinking Machine, CNC Die Sinking Machine, NC Turning Centre, Radial Drilling machines, Heavy Duty Plano miller, Lathes, Tool & cutter grinders, etc. The design and development of the die holds the key to blemish-free forgings.

At SIFL, we design both single-impression and multi-impression dies. The design, of course, is related to the forging drawings. And the decision on the type of die to be used, is based on the specific requirement of each case. The care that goes into the design of each die, also goes into the selection of raw materials and the sequence of operation that follows. To

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facilitate uninterrupted operations, SIFL is equipped with standby Power Generators.

To keep pace with hi-tech developments,SIFL has equipped itself with CAD,CAM facilities like DELCAM for three dimensional modeling of Product, Die & Tool design etc. thereby minimizing the development cycle time. All these qualities have helped SIFL grow quickly into a premier forging unit, capable of producing forgings with close dimensional tolerances

2.2 Forging and Heat Treatment Facilities

The billets for forging are heated in oil fired or electric furnaces, closely controlling the temperature to reduce the scale formation and overheating so that the metallurgical properties are ensured in the final product. In addition, in-process inspection is carried out at all stages and 100% inspection for visual defects after forging. The accepted forgings are duly heat treated to ensure its mechanical properties. By providing heat treatment services in-house, SIFL is able to maintain greater control over heat treating process. The facility comprise batch furnaces both oil fired & electrical, continuous electrical heating furnaces, solution treatment etc. to carry out annealing, normalizing, hardening, tempering, iso-thermal annealing, solution treatment etc. or other operations as specified by our customer. Close temperature control and process monitoring with the help of temperature recorders ensures uniform properties duly supported by evaluation of metallurgical properties through representative test pieces.

SIFL's critical forgings are supplied to various sectors like Aerospace sector, Defense sector, Railway sector, Heavy Engineering sector, Earth Moving sector, Agriculture sector, and Automobile sector SIFL is equipped to manufacture high pressure application forgings like Gate/ Valve Bodies, Choke Bodies etc. in Carbon and Alloy steel material, to meet the requirements of Oil Field Equipment manufacturers, Thermal Power Stations, Refineries, Petro-Chemical Industries and Nuclear Plants. The company has made significant contribution in Aerospace/Aeronautical sector by way of developing complex forgings for various aero engines.

3 DESIGN OF FIT BETWEEN DIE AND INSERT

3.1 Feasibility Study

In SIFL, they design both single-impression and multi-impression dies. The design, of course, is related to the forging drawings. And the decision on the type of die to be used is based on the specific requirement of each case. The care that goes into the design of each die. For production small components, Die and Insert is used for economical production.

In SIFLAthani to fit insert in a die block they use interference fit. An interference fit, also known as a press fit or frictional fit, is a fastening between two parts which is achieved by friction after the parts are pushed together, rather than by any means of fastening.

Diameter of Insert and Die.

Diameter of die= D

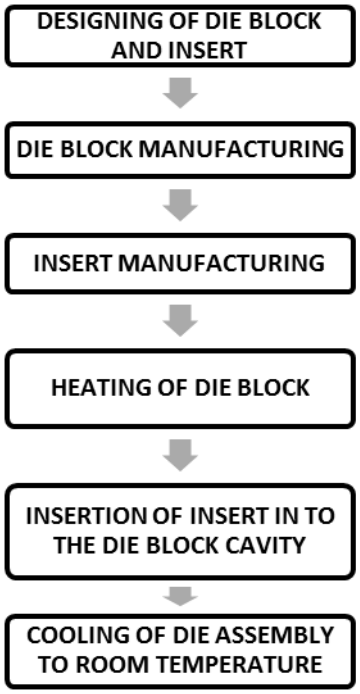
Diameter of insert= d

d=Dx1.0015

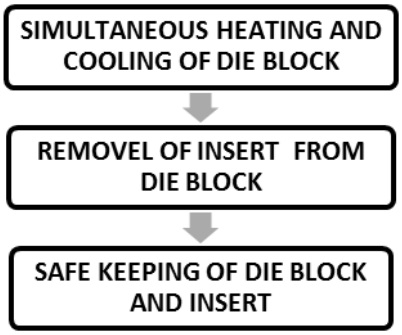
But the present method has some draw backs, so it needs a modification for more economic production.

3.2 Process chart

3.2.1 For Insertion of Die and Insert



3.2.2 Removal of Die and Insert.



3.3 Hammer Specification

3.3.1 Specification of 10 Ton Hammer Model:

M2150

Rated weight of falling parts with 1000kg

weight of top stamp=10,000 kg.

Effective kinetic energy of falling parts at full

successive blows= 260000 kg cm.

Maximum working stroke of ram= 1400 mm.

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Maximum height of stamps without shanks =

1000 mm.

Length of ram in direction perpendicular to front

of hammer = 1180 mm.

Length of stamp holder in direction

perpendicular to front of hammer = 1320 mm.

Pressure of air= 7-9 atm.

Rated weight of top stamp (die) = 1000 kg.

Maximum weight of top stamp (die) = 3000 kg.

Maximum permissible temperature = 200 degree c.

Weight of forged pieces= 40-100 kg.

The hammer permits stamping of simple parts from low alloy or carbon steel at temperature of forging 1100-1200a0c and area in the plane of the stamp joint not more than= 2500 $cm^{2.}$

3.3.2 Specifications of 6T Pneumatic Hammer

Double E - Acting, Ram Type Drop

Hammer MPM 16000 B

Full blow energy = 17500kg cm.

Weight of falling parts (without die) = 6255kg.

Ram full stroke =1000mm.

Guides spacing =850mm.

Die seat length in ram =900mm.

Die seat length in die holder =1250mm.

Die height (without tails), minimum =400mm.

Upper die weight, maximum =1800kg.

Die parting height over floor =740mm.

Number of blows per min =80 blows/min.

Steam pressure =6-8kg per sq. inch.

Air pressure =5-7kg per sq. inch.

Steam average consumption =1800kg per min.

Air average consumption =30cub m per min.

Cylinder dia =750mm.

Ram shank dia =550mm.

Inlet pipe dia =175mm.

Out let pipe dia =175mm.

Anvil block weight (without die holder) =

72+48 = 120 tons.

Weight of hammer with anvil blocks =168 tons.

3.3.3 1 Ton Pneumatic Power Hammer Technical

Specification Make: NESCO Engineering

Limited, Mumbai

Hammer size = 20 cwt.

Hammer speed = 90 blow per minute.

Horse power = 100 hp/1500 rpm.

Full load current = 134 amps.

Main cylinder diameter = 635 mm.

Piston dia = 634 mm.

Weight of falling parts in terms of ram =

1210 kg.

Stroke maximum = 815 mm.

Hit energy = 2929 kgms.

Sizes of job forge = 255 to 380 mm.

Diameter of ram = 406 mm.

Ram pallet face = 355*254 mm.

Anvil pallet face from floor = 610 mm.

Height above floor = 3545 mm.

Weight complete hammer with anvil block =

25600 kg.

Weight without anvil block = 15850 kg.

Lubrication oil capacity of the sump = 140lts.

3.4 Need for Replacement of Present Method.

- The need for heating the die up to 550°C for around 3hours in a furnace so that the die diameter expands up to a diameter in which the insert can fit.
- Once the insert is introduced into the die cavity the die is cooled so that there is a perfect fit between the insert and the die.
- This method is not cost effective and it is also time consuming.

3.5 Proposed alternative method.

- Assemblages of split die block using dovetail.
- Design Tapered vertical key.

4 ASSEMBLAGE OF SPLIT DIE BLOCK USING DOVE TAIL.

The upper half of the die block is divided in to two mating parts. Insert is introduced between the gaps of mating parts. These are assembling using dovetail joint. A tapered key is used for perfect key alignment of the mating parts.

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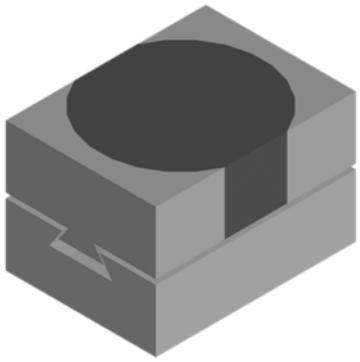
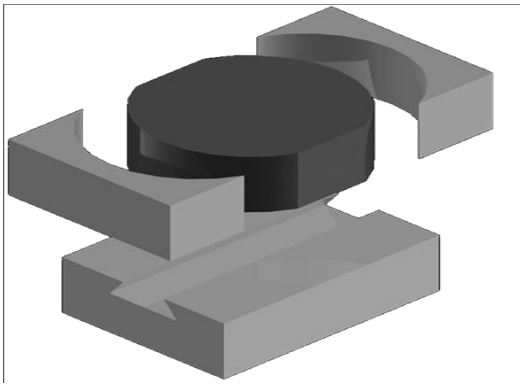




4.1 Merits

- Cost effective
- Simple in assembling
- Stronger than tapered vertical key method
- No need of heat treatment
- Less time consuming for assembling
- Improve productivity

4.2 Mathematical Stimulation.

Steam pressure =

$8Kg/inch^2 = 8(39.372)^2 9.81 = 121656.11\ N/m^2$

Air pressure = $7Kg/inch^2 = 106449.1015\ N/m^2$

Hammer area =

$\pi r^2 h = \pi(0.375)^2(0.400)^2 = 0.1767 m^2$

Force acting due to steam and air pressure =

(121656.11+106449.10)(0.1767) = 40306.19N

Mass of hammer with anvil block= 1648080N

Mass of falling part= 6255(9.81)=61361N

Total force acting= 17497470.19N

Crushing stress= total force/crushing area

Crushing area= Total force / crushing

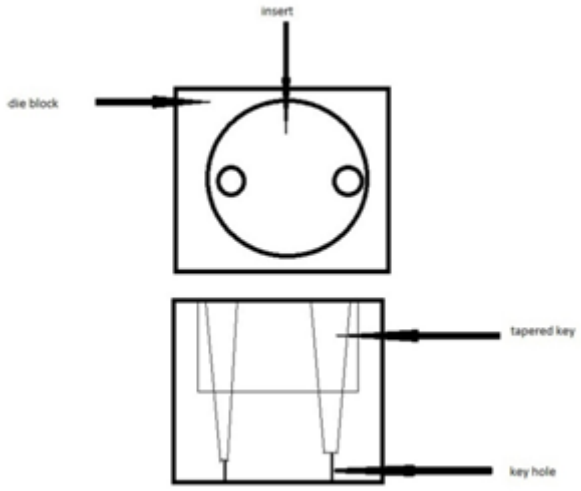
Stress =17497470.19/(470*10^6)=0.0372m²

5 DESIGN OF TAPERED VERTICAL KEY.

This method is employed mainly for low tonnage pneumatic hammer. A number of vertical tapered key is used in order to make the insert perfectly fit inside the die cavity. The arrangement of key must be such the load acting on the key must tighten the insert. So that no misalignment happens.

5.1 Merits.

- Cost effective
- Less material usage
- Simple in assembling
- No need of heat treatment
- Less time consuming for assembling
- Improve productivity.



6 ACKNOWLEDGMENT.

The aim of this project was to study various processes in forging and to replace the interface fit by a suitable method in such a manner that alignment of the insert does not change during forging process. The forging process was observed and various methods were suggested and best suitable method was studied and developed.

7 REFERENCE.

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